Birch Stream Total Maximum Daily Load (TMDL)
Draft Report

Below Airport Mall (May 2004)

Below Ohio Street (August 2003)

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LIST OF ACRONYMS USED

BMP	Best Management Practice
CMC	Criteria Maximum Concentration(for toxic contaminants)
CSO	Combined Sewer Overflow
CWP	Center for Watershed Protection
ENSR	ENSR Corporation
GIS	Geographic Information System
IC	Impervious Cover
LA	Load Allocation
MDEP	Maine Department of Environmental Protection
MRSA	Maine Revised Statutes Annotated
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
PETE	Partnership for Environmental Technology Education
SI	Stressor Identification
SVOC	Semi-volatile organic compounds
SWAT	Surface Water Ambient Toxics
SWQC	(Maine's) Statewide Water Quality Criteria
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
US EPA	U.S. Environmental Protection Agency
WLA	Waste Load Allocation

PART I: WATERBODY DESCRIPTON, IMPAIRMENTS, TMDL TARGET, AND BMP IMPLEMENTATION RECOMMENDATIONS

1. DESCRIPTION OF WATERBODY

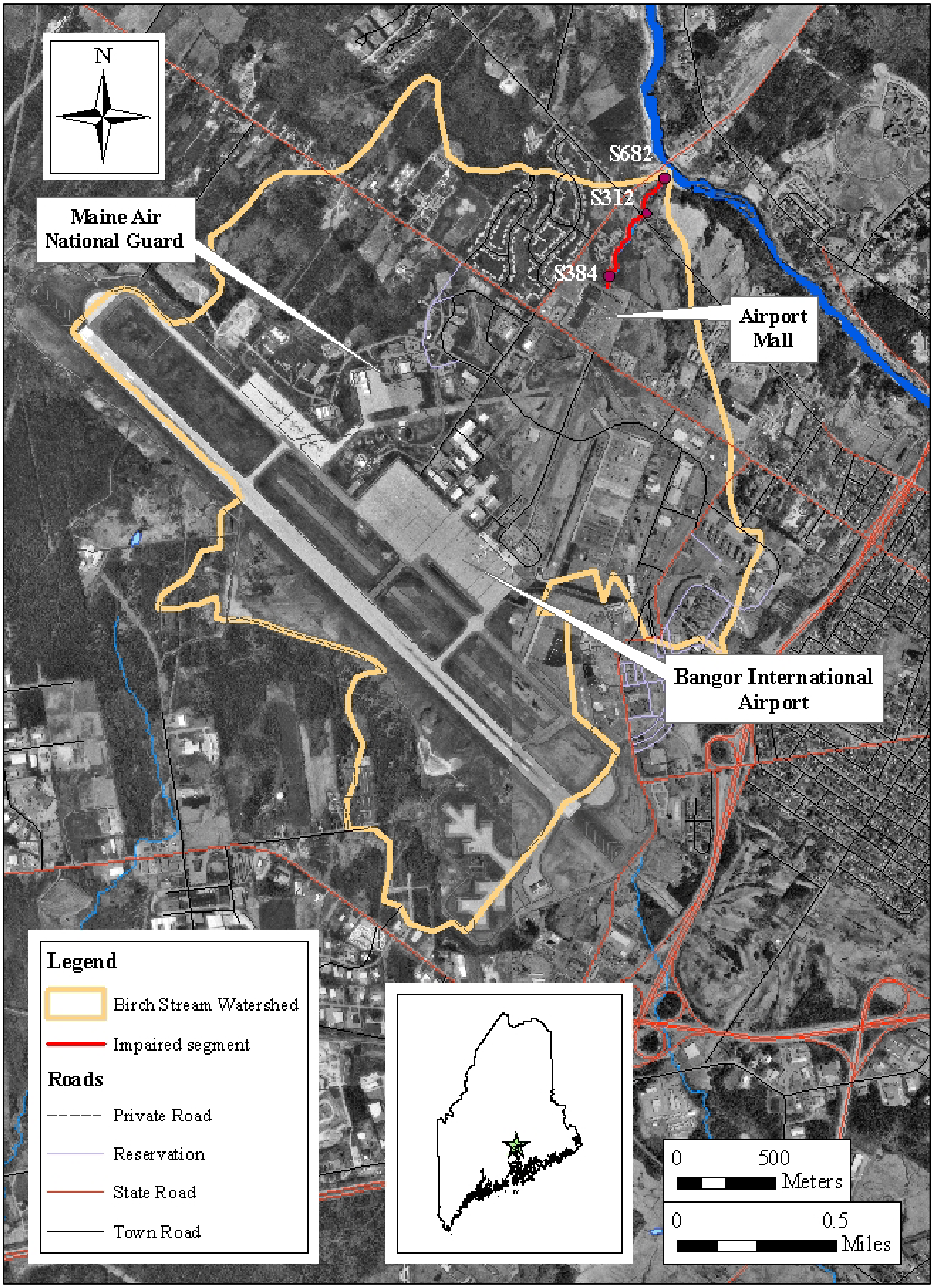
Description of Waterbody and Watershed

Birch Stream (Fig. 1) in Bangor (central Maine, 44°49'N, 68°48'W, HUC ME0102000510) is a short stream (~0.5 miles) with a moderate watershed size (~1,900 acres). The stream, which does not have any tributaries, originates in an area that is occupied by an airport complex made up by the Bangor International Airport and, to a much smaller extent, the Maine Air National Guard. Within the airport complex, Birch Stream is channelized, culverted, and portions of the stream bed are covered with concrete. As a result, the stream in this area does not function like a natural system. The stream then crosses underneath a road and the Airport Mall, and exits from a large culvert behind the Mall, where the stream proper begins. From here on, Birch Stream flows through a mostly residential area, crosses underneath another road, and then flows over a natural waterfall and into Kenduskeag Stream. For the purposes of this TMDL, "Birch Stream" refers to that portion of the stream that resembles a natural stream, i.e., the portion between the Airport Mall and the confluence with Kenduskeag Stream. Appendix A contains a set of photos of the stream.

During summer baseflow conditions, the stream has a wetted width of 3.5-5.5 m and a bankfull width of 5.5-17.1 m; water depth is generally 8-15 cm with a few deeper areas. The stream substrate consists of mixture of boulders, rubble, and gravel with little sand. Below the waterfall, some bedrock is present. The morphology of this medium-gradient stream is a mixture of riffles-runs and steps-pools. The riparian buffer along approximately half of the stream has been eliminated; along the remaining half, the buffer consists of trees with an understory of herbaceous plants, shrubs, and ferns, but in some areas invasive Japanese Knotweed (*Polygonum cuspidatum*) or lawn have replaced a natural buffer.

The upper part of the watershed (above Union Street) was first developed in the 1940s when the area became a military reservation (Dow Field). In the 1960s, the military base closed down and Bangor International Airport was created. In the lower part of the watershed, there was only minimal development until the 1960s, but development accelerated in the early 1970s when the Airport Mall opened. The entire watershed is classified as a "regulated area" under the NPDES Phase II Stormwater Program. Facilities in the airport complex are also regulated pursuant to NPDES Phase I Stormwater Rules.

Fig. 1. Birch Stream watershed, impaired segment, and location of biomonitoring stations.



Impaired Stream Segment

A 0.5 mile segment of Birch Stream, which is classified as a Class B stream[1], was included in Maine's 2002 and 2004 303 (d) lists (MDEP 2002b, 2004b). The listing was based on a preliminary stream assessment and sampling results from the Biological Monitoring Program of the Maine Department of Environmental Protection (MDEP; see Description of Impairments, below). Additional data collected throughout the watershed in 2003 confirmed that the entire length of the natural stream (0.5 miles; from the Airport Mall to the confluence with Kenduskeag Stream) is impaired (PETE/MDEP 2005).

2. IMPAIRMENTS AND STRESSORS OF CONCERN

Detection of Impairments

Maine has an ongoing biological monitoring program within the MDEP, as well as biological criteria for the different classes of rivers and streams in Maine (38 MRSA § 465). The biomonitoring program uses a tiered approach to protecting aquatic life uses, and assesses the health of rivers and streams by evaluating the composition of resident biological communities (mainly benthic macroinvertebrates), rather than (or sometimes in conjunction with) directly measuring the chemical or physical qualities of the water (such as dissolved oxygen levels or concentrations of toxic contaminants)[2]. This biological assessment approach is extremely useful, especially for small streams impaired by stormwater runoff and the mix of associated pollutants, because benthic organisms integrate the full range of environmental influences and thus act as continuous monitors of environmental quality.

Description of Impairments

Maine's 2002 and 2004 303 (d) lists (MDEP 2002b, 2004b) note "Aquatic life"[1] as the impaired use for Birch Stream with "Urban NPS (airport runoff, deicing[3])" as the potential source for the impairment. This assessment was based on data collected by the MDEP Biomonitoring unit on macroinvertebrate communities at one station in Birch Stream in 1997 and 2001 (station S312), and two stations in 1999 (S312 and S384) and 2003 (S312 and S682, see Fig. 1 and Appendix A, Figs. 2, 3 and 5). The aquatic life criteria set for a Class B stream (see Part II, Table 1) were not met in any sampling event, and in three out of six sampling events Maine's minimum aquatic life criteria (Class C) were not met. In addition, in 2004, samples collected at S312 did not meet Class C criteria but samples collected at S682 did. Monitoring results were documented in the MDEP's SWAT (Surface Water Ambient Toxics) Program Reports (MDEP 2000, 2001a, 2002a, 2004a) as well as in the Urban Streams Project Report (PETE/MDEP 2005).

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1 See Part II, section 2, Maine State Water Quality Standards for further explanation.
2 Note that all of Maine's water quality standards have to be met for a waterbody to attain its classification.
3 The 2002 303 (d) did not specify the types of Urban NPS sources.

Stressors of Concern and Their Sources

The 303 (d) lists (MDEP 2002b, 2004b) and SWAT reports (MDEP 2000, 2001a, 2002a, 2004a) indicated "Urban NPS (airport runoff, deicing)" as the potential source for the impairment of the macroinvertebrate community. To gain a better understanding of specific stressors and their sources responsible for Urban NPS pollution in Maine, the MDEP in 2003 launched a special project to collect a large amount of biological, chemical, and physical data throughout four urban watersheds, including the Birch Stream watershed. The data collected under the "Urban Streams Nonpoint Source Assessments in Maine" project, or Urban Streams Project (PETE/MDEP 2005), were analyzed during a series of Stressor Identification (SI) workshops held in May and June 2004. For Birch Stream, the SI analysis confirmed overall urban development as the primary factor responsible for stressors directly or indirectly linked to aquatic life impairments. No discreet non-stormwater point source of pollution was identified in the Birch Stream watershed although there are three stormwater outfalls in the stream [two at the outflow of the culvert underneath the Airport Mall (Appendix A, Fig. 9), one immediately above Ohio Street], two facilities (Bangor International Airport, Maine Air National Guard) with one stormwater detention pond each that discharges to the channelized portion of the stream, and one facility (Sunbury Village) with a stormwater detention pond that does not discharge directly to the stream (S. Beyer, MDEP, pers. comm.). Following is a list of the five stressors that were identified in the stressor identification analysis as major factors causing the impairment, and the data this determination was based on. Extensive documentation of sampling results is provided in Chapter 3 of PETE/MDEP 2005; Chapter 2 of the report details sampling methods and provides information on the SI analysis.

<u>Stressor 1: Propylene glycol</u>

Negative effects of propylene glycol (deicer) discharge into the stream from the airport complex was indicated by observations [heavy mats of the bacterium *Sphaerotilus* (Appendix A, Fig. 11), anoxia on stream bottom, milky water, noxious odor], low DO concentrations in spring, and high levels of Biochemical Oxygen Demand (BOD).

Note that the propylene glycol input to the stream was much reduced when the Air National Guard (the main user of deicer) and Bangor International Airport completed remedial actions in the fall of 2003. Further improvements to the system were carried out in the fall of 2004. Propylene glycol is expected to be a less important stressor from 2005 onwards, and is therefore not included as a separate item in this TMDL.

<u>Stressor 2: Presence of toxic contaminants</u>

Various toxic contaminants exceeded relevant criteria in a number of sampling events (for details see Chapter 3 of PETE/MDEP 2005). Aluminum exceeded Maine's Statewide Water Quality Criteria (SWQC) CMC (Criteria Maximum Concentration) during stormflow conditions in November 2003. Certain semi-volatile organic compounds (SVOCs; PAHs and benzidine) exceeded Maine guidelines for remedial actions and/or EPA remediation goals during baseflow conditions in June 2003. And Diesel Range Organics (DRO) in sediment exceeded Maine guidelines in August and November 2003. The role of toxic contaminants as a stressor was also indicated by high conductivity levels in the stream and signals from the macroinvertebrate community.

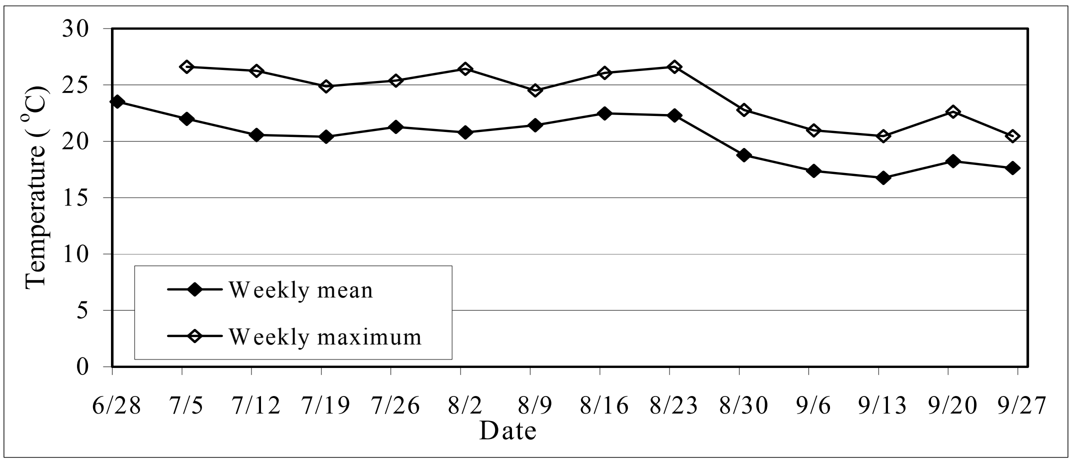
Stressor 3: High peak flows

A geomorphological survey found evidence of erosion attributable to increased peak flows related to impervious surfaces (Field 2003; Appendix A, Fig. 12). Personal observations after storm events also indicated the occurrence of high peak flows.

Stressor 4: Elevated water temperature

High weekly mean and maximum temperatures above 20 and 25 ºC, respectively, were recorded from early to mid-summer 2003 at biomonitoring station S312 (Fig. 2). A similar pattern was found at station S682, although temperatures there were only measured between July 30 and September 27, 2003 (PETE/MDEP 2005).

Fig. 2. Weekly mean and maximum temperatures at station S312 in 2003.



Stressor 5: Elevated nutrients

Total Phosphorus and Total Nitrogen exceeded EPA's recommended nutrient criteria for Ecoregion VIII in all baseflow and stormflow sampling events at both stations (Table 1).

Table 1. Nutrient sampling results (in mg/L) from stations S312 and S682 in 2003 and 2004. TP, Total Phosphorus; TN, Total Nitrogen. *, exceeds the EPA-recommended nutrient criterion for Ecoregion VIII.

Flow conditions	Date	S312		S682	
		TP	TN	TP	TN
Baseflow	7/16/03	0.100*	1.49*		
	8/13/2003	0.054*	0.75*		
	8/27/2003	0.028*	0.77*		0.64*
	9/10/2003	0.035*	0.78*		
	8/5/2004	0.021*	0.63*	0.021*	0.62*
	8/24/2004	0.020*	0.79*	0.022*	0.79*
Stormflow	11/20/2003	0.084*			
EPA Ecoregion VIII criterion		0.01	0.38	0.01	0.38

Table 2 lists the likely and possible sources responsible for the stressors identified during the stressor identification analysis. Some identified sources (italicized in Table 2) represent natural conditions, while several sources (highlighted in Table 2) are related to watershed imperviousness. For example, for the stressor 'Presence of toxic contaminants', the following sources are linked to impervious surfaces present in the watershed: runoff from airport area, local roads, and parking lots; and winter road sand/road dirt. These sources and the resulting stressor are generally absent, or of minor importance, in non-urbanized watersheds. Recent studies (as summarized in CWP 2003) have shown that the percentage of impervious cover (IC) in a watershed strongly effects the health of aquatic systems because land surfaces that block infiltration of rainwater cause increased amounts of stormwater to run off into gutters, untreated storm sewers or directly to streams. In general, stream quality declines as imperviousness exceeds 10 % of watershed area, and may be severely compromised at greater than 25 % (Schueler 1994, CWP 2003). In Maine, existing local data indicate that an impervious cover of 7-10 % is adequate for attainment of Class B aquatic life criteria (MDEP 2005).

Table 2. Identified stressors and their sources in the Birch Stream watershed. Sources representing natural conditions are italicized, those that are related to impervious surfaces are highlighted.

Stressor	Importance	Sources	
		Likely	**Possible**
1) Propylene glycol	High*	De-icer runoff from airport complex	
2) Presence of toxic contaminants	High	Runoff from airport area, local roads, and parking lots	Winter road sand/road dirt
		Documented spills (mostly of petroleum products)	*Natural sources*
		Dumping	Atmospheric deposition
			Sewage system leaks
3) High peak flows	Medium	High percentage of impervious surfaces	Stormwater outfalls
4) Elevated water temperature	Medium	Impervious surfaces	
		Reduced riparian shading	
		Detention ponds	
5) Elevated nutrient levels	Medium	Runoff from local roads and parking lots	Lawn/landscaping runoff
			Animal waste from pets and wildlife
			Detention ponds
			Reduced riparian buffer
			Sewer leaks
			Atmospheric deposition

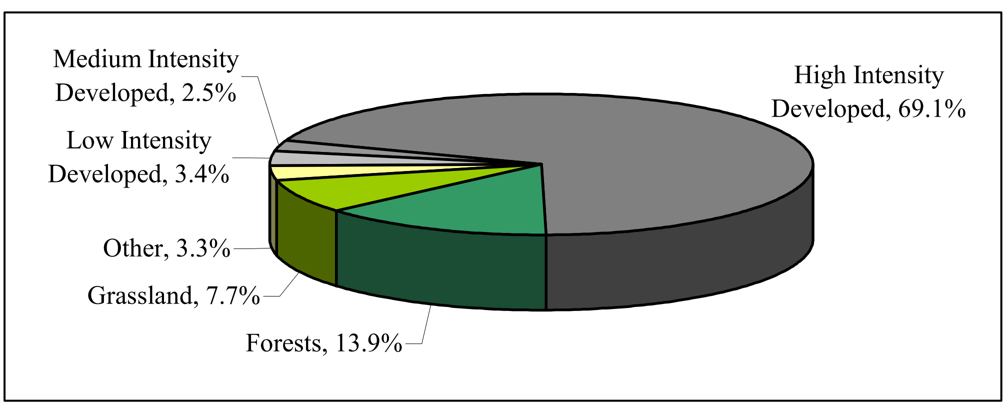
* Following remedial actions at the airport complex, the importance of this stressor is expected to decline.

3. IMPERVIOUS COVER AND LANDUSE INFORMATION

Urban development primarily affects aquatic systems due to the high percentage of impervious cover (IC) present in urban areas. Effects include impairments in water quality, stream morphology, hydrology, and aquatic communities (CWP 2003). For Birch Stream, the relationship between IC and the stressors identified for this waterbody is shown in Table 2. The parameter "impervious cover" serves as a surrogate for a variety of impairments that are related to stormwater runoff because it relates the primary causal factors to specific impairments (ENSR 2004). Stormwater runoff is water that does not soak into the ground during a rain storm but flows over the surface of the ground until it reaches a nearby waterbody. Stormwater runoff often picks up pollutants such as soil, petroleum products, fertilizers, pesticides, and animal waste. These pollutants may originate from driveways, roads, parking lots, and lawns located within a watershed[1]. The negative effects of urban stressors on overall stream quality can be reduced by disconnecting impervious surfaces from the stream so that runoff does not reach a waterbody untreated or converting impervious surfaces to pervious surfaces. Implementation of other measures that address habitat restoration, flood plain recovery, and riparian recovery can be an effective and less costly first step in abatement. More information on these Best Management Practice (BMP) options is provided in section 5, Implementation Recommendations.

The % impervious cover in the Birch Stream watershed was determined from landuse data and a conversion of landuse to % IC. Details regarding this procedure are given in Part II, section 3. Analysis showed that landuse is dominated by high, low, and medium intensity development, which together account for 75 % of all landuses (Fig. 3; see also Part II, Table 2, and Appendix A, Fig. 8). The majority of these developments are located within the airport complex. Forests and grasslands account for 14 and 8 %, respectively, while other smaller landuses make up the remaining 3 %. Converting landuse to % IC, imperviousness in the Birch Stream watershed was estimated to be 33 %. This percentage reflects the total amount of impervious cover in this watershed.

Fig. 3. Distribution of landuse types, with percentages, in the Birch Stream watershed.



[1] For more information on stormwater issues visit the MDEP Nonpoint Source Pollution website at www.maine.gov/dep/blwq/doceducation/nps/background.htm

4. TOTAL MAXIMUM DAILY LOAD (TMDL) TARGET

Details regarding the determination of the TMDL target set for Birch Stream are given in Part II of this document, and a brief summary is provided here. For further details please consult Part II.

Non-attainment of water quality criteria in Birch Stream suggests that this stream has exceeded its loading capacity, namely the mass of pollutants a waterbody can receive over time and still meet water quality targets. The Stressor Identification (SI) analysis indicated that urban stressors have caused the impairment in the macroinvertebrate community and the failure to attain aquatic life criteria. “Urban stressors” is a catch-all term encompassing a wide variety of effects caused by urbanization, with the majority of the effects being related, directly or indirectly, to stormwater runoff from impervious surfaces. Because of the major effect stormwater runoff has on aquatic systems (CWP 2003), the “Impervious Cover Method” (IC method), as employed by ENSR in a pilot TMDL (ENSR 2004), is used here to estimate current and target annual runoff volumes and annual pollutant loads for Birch Stream based on a target % IC of 8 %. Parameters used in load estimates are annual runoff, annual rainfall, pollutant concentration in runoff (event mean concentrations), and watershed area. The target % IC was determined in accordance with MDEP guidance (MDEP 2005) using MDEP data, information from the literature, and local conditions.

5. IMPLEMENTATION RECOMMENDATIONS

The goal of this TMDL is to have Birch Stream meet applicable water quality criteria, that is to have the macroinvertebrate community attain Class B standards. Impairments observed in the aquatic communities in Birch Stream have been attributed to urban stressors, including additional stormwater runoff from impervious surfaces. Stormwater effects can be lessened, water quality improved, and impairments curtailed by implementing best management practices (BMPs) and remedial actions in a cost-effective manner using the following adaptive management approach:

- Implement BMPs strategically through a phased program which focuses on getting the most reductions, for least cost, in sensitive areas first (for example, begin with habitat and riparian buffer restoration, flood plain recovery, and treatment of smaller, more frequent storms);
- Monitor ambient water quality to assess stream improvement;
- Compare monitoring results to water quality standards (aquatic life criteria);
- Continue BMP implementation in a phased manner until water quality standards are attained.

Generally speaking, these abatement measures can take one of three forms: they can consist of general stream restoration techniques (including habitat, riparian buffer, and flood plain restoration), they can disconnect impervious surfaces from the stream, or they can convert impervious surfaces to pervious surfaces. Local conditions will determine which measures are most appropriate for a given watershed. In general, practices that achieve multiple goals are preferred over those that achieve only one goal (ENSR 2004). For example, installing a detention basin along with runoff treatment systems provides more effective abatement of stormwater pollution than installing detention BMPs alone. Because of the effort and cost involved in implementing BMPs, a long-term strategy can be used to achieve water quality standards. For example, lower cost general stream or buffer restoration techniques that lessen stormwater effects immediately can be implemented in the short-term to initiate stream recovery.

This TMDL sets a target of 8 % impervious cover (IC). This target, and the current extent of IC of 33 %, reflect the total amount of impervious cover in the Birch Stream watershed. For practical purposes, the IC calculations in this TMDL do not distinguish between directly connected and disconnected surfaces. In any watershed, the runoff from impervious cover reaches the stream through both direct and indirect conduits that represent varying levels of stormwater treatment. A comprehensive sub-watershed survey of outlet structures and storm drainages would be needed to completely evaluate the amount of 'effective'[1] versus 'total' IC. Municipalities and entities that own extensive impervious surfaces are encouraged to conduct such surveys. Because effective IC presents the greatest pollution risk, efforts to disconnect or convert impervious surfaces should be directed primarily at these areas to ensure maximum benefit. This approach is likely to accelerate stream recovery and reaching the goal of this TMDL, i.e. attainment of water quality criteria. If criteria are attained before the target % IC is reached, the need for further reductions in impervious cover would be reduced (or possibly eliminated). It should be noted, however, that while a sub-watershed survey would be ideal for comprehensive planning towards stream restoration, immediate stormwater remediation may be more beneficial in the short run. Disconnecting 'hot spots' and installing bioretention structures may move the stream closer to the water quality target than documenting the current extent of effective IC.

The following three sections list the options available for BMPs aimed at stream restoration techniques, and disconnection and conversion of impervious surfaces. Because many factors must be considered when choosing specific structural BMPs (e.g., target pollutants, watershed size, soil type, cost, runoff amount, space considerations, depth of water table, traffic patterns, etc.), the sections below only suggest categories of BMPs, not particular types for particular situations. Implementation of any BMPs will require site-specific assessments and coordination among local authorities, industry and businesses, and the public. Advice on the selection, design, and implementation of any remedial measures can be obtained from the MDEP (Bureau of Land and Water Quality, Division of Watershed Management), the Penobscot County Soil and Water Conservation District, or web-based resources (see Appendix B for suggestions).

In summary, implementation of remedial measures will occur under an adaptive management approach in which certain measures are implemented, their outcome and effectiveness evaluated, and future measures selected so as to achieve maximum benefit based on new insights gained. This process may be repeated several times, starting with the most appropriate measures for the area. The order in which measures are implemented should be determined with input from all concerned parties (e.g., city, airport authorities, businesses,

[1] 'Effective' IC is impervious cover that that is directly connected to the stream via hard surfaces or in close proximity, and from which runoff enters a waterbody untreated.

industry, residents, regulatory agencies, watershed protection groups). It is suggested that the City develops implementation recommendations by the end of 2006 and presents them to the watershed stakeholders and, if desired, the MDEP or the Penobscot County Soil and Water Conservation District. Further details on the measures suggested below is provided in Chapter 3 of the Urban Streams Report (PETE/MDEP 2005). In addition, Appendix C lists BMPs in a matrix format in which traditional and newly developed ("Low Impact Development") BMP types are rated according to their ability to mitigate for impacts of impervious cover and applicability to certain urban situations (ENSR 2005). The matrix was developed by ENSR as a multi-use tool and thus contains some BMPs and IC impacts not directly applicable to Birch Stream.

General Stream Restoration Techniques

Following is a list of general BMPs and stream restoration techniques and how they can alleviate stressors and improve stream health. Short-term implementation of these measures will complement the long-term strategy of disconnecting or removing impervious surfaces suggested above. Web-based information resources that can aid with planning and implementing these measures are given in Appendix B.

- Maintaining the riparian buffer where it is adequate, i.e., has a width of at least 23 m (75 feet), wherever possible, and is composed of native plants, including mature trees. Enhancing or replanting the riparian buffer where it is inadequate. An adequate buffer will filter runoff from commercial and residential lots, improves shading (which helps to keep water temperature low), and increases large woody debris availability, and food input. It will also provide terrestrial and aquatic habitat for insects with aquatic life stages, thus enhancing recolonization potential of the macroinvertebrate community.
- Reclamation of flood plains by returning these areas to a natural state will naturally moderate floods; reduce stress on the stream channel; provide habitat for fish, wildlife, and plant resources; promote groundwater recharge; and help maintain water quality. Protection of intact flood plains should be a high priority.
- Improving channel morphology (a narrower, less braided channel) by blocking secondary flow paths and adding roughness to the channel (see Field 2003, Fig. 9c, or PETE/MDEP 2005, Chapter 3, Fig. 26) will create a more stable and natural condition with improved habitat for macroinvertebrates. However, since channel morphology is degraded due to excessive erosion caused by high peak flows resulting from impervious surfaces, channel restoration activities need to be preceded by flow reductions to be successful (Field 2003; PETE/MEP 2005). Furthermore, because of the complex nature of channel restoration, any improvement activity will require the extensive involvement of a trained professional.
- Reducing the incidence of spills (accidental and deliberate) for example by improving education and training will reduce toxic contaminant input. Documented spills were identified as a likely source for the presence of toxic contaminants in the stream.
- Reducing the input of winter road sand and road dirt by sweeping roads, parking areas or driveways will reduce toxic contaminant and sediment input.
- Eliminating the potential for sewer system leaks will reduce toxic contaminant and nutrient input. A strong sewer smell near the downstream biological monitoring

station (S682, see Fig. 1) was still observed in July 2005 (L. Tsomides, MDEP, pers. comm.). This suggests the continued possibility of sewage influx into the stream.

- Reducing the temperature of water discharged from a detention structure by redesigning and retrofitting existing detention with outlet structures (e.g., underdrains) that cool the discharge will reduce negative temperature effects on the stream.
- Minimizing lawn/landscaping runoff by minimizing fertilizer/pesticide use and using more efficient application methods will reduce nutrient and toxic contaminant input.
- Minimizing waste input from pets by picking up waste will reduce bacteria and nutrient input.
- Performing regular maintenance on detention ponds will reduce export of accumulated sediment and nutrients into the stream during large storms.
- Investing in education and outreach efforts will raise public awareness for the connections between urbanization, impervious cover, stormwater runoff, and overall stream health.
- Encouraging responsible development by promoting Smart Growth or Low-Impact Development guidelines and the use of pervious pavement techniques will minimize overall effects of urbanization.
- Reducing new impervious cover by promoting shared parking areas between homes or between facilities that require parking at different times will reduce impacts related to impervious surfaces. Lowering minimum parking requirements for businesses and critically assessing the need for new impervious surfaces will have the same effect.
- Discouraging the use of pavement sealants on driveways and parking lots will reduce the input of toxic contaminants. A recent study showed that runoff from sealed parking lots could account for the majority of the PAH load in urban streams (Mahler et al. 2005). PAHs are a group of toxic contaminants with known negative effects on aquatic communities. Sealants are often applied for aesthetic reasons only, and decreasing their use represents a simple way to reduce the toxics load in runoff.

<u>Disconnection of Impervious Surfaces</u>

The purpose here is to prevent stormwater runoff from reaching the stream directly (via the storm drain system). There are various options for achieving this goal:

- Channel runoff from large parking lots, airport runways or taxiways, roads or highways into
  - detention/retention BMPs (e.g., dry/wet pond, extended detention pond, created wetland), preferably one equipped with a treatment system (e.g., underdrains);
  - vegetative BMPs (e.g., vegetated buffers or swales);
  - infiltration BMPs (e.g., dry wells, infiltration trenches/basins, bio-islands/cells);
  - underdrained soil filters (e.g., bioretention cells, dry swales).

  Treatment of runoff from airport runways or taxiways is critical if these surfaces are treated with deicers during the winter season. At present, it is unknown which deicing compounds are used; this information needs to be obtained during the implementation phase of this TMDL to determine the need for targeted runoff treatment.
- Redesign and retrofit existing detention to provide extended detention for 6 month and 1 year storms.

- Guide runoff from paved driveways and roofs towards pervious areas (grass, driveway drainage strip, decorative planters, rain gardens).
- Remove curbs on roads or parking lots.
- Collect roof runoff in rain barrels and discharge into pervious areas.

All of these options for disconnection of impervious surfaces provide for a virtual elimination of runoff during light rains (which account for the majority of runoff events but not the majority of pollutant or stormwater input), reduction in peak discharge rate and volume during heavy rains, sedimentation or filtration of some pollutants, and improvement in groundwater recharge. Disconnection of impervious surfaces can often be achieved at reasonable cost and, unlike the removal of impervious surfaces (below), does not generally create material for disposal. These BMPs cover most sizes of impervious surfaces (private driveways and small building roofs to large parking lots and highways), and many have been widely used in cold climates. Disconnection of impervious surfaces is a particularly useful option in watersheds with high imperviousness, such as the Birch Stream watershed.

Two retention ponds within the airport complex, which occupies the majority of the watershed (Fig. 1), already exist (J. Murphy and M. Ward, City of Bangor; R. Madden, Bangor International Airport; Lt. Col. E. Johns, Maine Air National Guard; pers. comm.). However, the finding of the Urban Streams Project (PETE/MDEP 2005) that stream impairments are to a large extent related to impervious surface runoff (see Table 2) suggests that the treatment provided by these BMPs may be insufficient to ensure adequate water quality in Birch Stream.

Conversion of Impervious Surfaces

This is achieved by replacing impervious surfaces with pervious surfaces, for example by using the following BMPs:

- Replace asphalt on little-used parking lots, driveways or other areas with light vehicular traffic with porous pavement blocks or grass/gravel pave.
- Replace small areas of asphalt on large parking lots with bioretention structures (bio-islands/cells).
- Replace existing parking lot expanses with more space-efficient multistory parking garages (i.e., go vertical).
- Replace conventional roofs with green roofs.

These options for conversion of impervious surfaces also provide for a virtual elimination of runoff during light rains (which account for the majority of runoff events), reduction in peak discharge rate and volume during heavy rains, filtration of some pollutants, and improvement in groundwater recharge. However, a number of problems exist with these options (e.g., removed asphalt or roofing shingles must be landfilled or recycled), and removal of existing impervious surfaces may be operationally unfeasible. Some of these BMPs are still in the experimental stage for cold climates and may not prove suitable for widespread implementation. Use of these BMPs may therefore be limited to relatively few instances. As far as possible, construction or building projects should, however, consider these and other possibilities for reducing new impervious cover during the planning stages.

6. MONITORING PLAN

Maine DEP will evaluate the progress towards attainment of Maine's water quality standards by monitoring the macroinvertebrate community in Birch Stream under the Biomonitoring Unit's existing rotating basin sampling schedule. At the same time, the Streams TMDL unit will collect water chemistry samples during stormflow conditions to determine whether acute criteria of the Maine Statewide Water Quality Criteria for certain toxic contaminants or sediment are exceeded. Adaptive implementation of the remedial measures listed above should be pursued until aquatic life criteria are met. Once criteria have been met in at least two sampling events with normal summer conditions within a 10-year period (i.e., by 2015), no further remedial measures are required. If criteria continue to be violated once BMPs and restoration techniques have been implemented and the IC has been reduced to 8 %, this TMDL will enter a secondary phase in which the approach proposed in this document will be reassessed.

PART II: TMDL PLAN

1. PRIORITY RANKING, LISTING HISTORY, AND ATMOSPHERIC AND BACKGROUND LOADING

Priority Ranking and Listing History

The large number of streams listed for nonpoint source (NPS) pollution on the 303 (d) list requires Maine to set priority rankings based on a variety of factors. Factors include the severity of degradation, the time duration of the impairment, and opportunities for remediation. Maine has set priority rankings for 303 (d) listed streams by TMDL report completion date, and has designated Birch Stream for completion by 2005. Birch Stream's priority ranking was raised on the 2004 303 (d) list (MDEP 2004b) when the stream was included in the Urban Streams NPS Assessment Project (PETE/MDEP 2005).

Atmospheric Deposition

Atmospheric deposition of pollutants (metals) that occurs within a watershed will reach a stream through runoff containing material deposited on land, direct contact of the stream with rain, and the settling of dry, airborne material on the stream surface. As for contaminated runoff, it is assumed that in watersheds with a relatively low percent imperviousness enough soil remains that most atmospherically deposited metals are buffered and adsorbed before they can reach the stream (except in watersheds sensitive to acidification). Where imperviousness is quite high, as in the Birch Stream watershed (33 %), it is unknown whether, or how much, material deposited from the atmosphere reaches a stream with runoff. A reduction in the % impervious cover (IC) in the watershed would help in reducing any negative effects from pollutants derived from the atmosphere. However, because this type of pollution originates from very diffuse and potentially far-away and wide-spread sources, national action is required to deal with this issue effectively. Other potential sources (i.e., direct contact with rain, and deposition in the stream of airborne material) are considered to convey minimal loads to Birch Stream because of the small surface area of the stream channel itself.

Natural Background Levels

No part of Birch Stream is in what could be called a "natural setting" as the entire watershed has been strongly affected by human activities. As a result, no information on natural background levels of pollutants in this watershed is available. In general, it is difficult to separate natural background loads from the total nonpoint source load (US EPA 1999), and the information would not contribute significantly to the analysis for this TMDL.

2. DESCRIPTION OF THE APPLICABLE WATER QUALITY STANDARDS

Maine State Water Quality Standards

Water quality classification and water quality standards of all surface waters of the State of Maine have been established by the Maine Legislature (Title 38 MRSA 464-468). According to Maine's Water Classification Program, Birch Stream is classified as Class B. Table 1 summarizes the water quality standards applicable to Birch Stream. The Maine Legislature also defined designated uses for all classified waters, which state that "Class B waters shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as habitat for fish and other aquatic life. The habitat shall be characterized as unimpaired."

Table 1. Maine water quality criteria for classification of Class B streams (38 MRSA § 465).

Numeric Criterion	**Narrative Criteria**	
Dissolved Oxygen	**Habitat**	**Aquatic Life (Biological)**
7 ppm; 75% saturation	unimpaired	Discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes to the resident biological community.

Antidegradation Policy

Maine's anti-degradation policy requires that "existing in-stream water uses and the level of water quality necessary to sustain those uses, must be maintained and protected." (For designated uses of a Class B stream see previous section.) Additionally, MDEP must consider aquatic life, wildlife, recreational use, and social significance when determining "existing uses".

3. TMDL TARGET: LOADING CAPACITY AND IMPERVIOUS COVER

Loading Capacity

Loading capacity is the mass of pollutants that a waterbody can receive over time and still meet numerical or narrative water quality targets. Birch Stream currently does not meet Maine's aquatic life criteria for a Class B stream (Table 1), suggesting that its loading capacity is exceeded. For streams in urbanized areas, additional stressors affecting aquatic life exist in the form of non-pollutant impacts such as alterations in channel morphology and the flow regime, or elimination of the riparian buffer. Stressors should be controlled to bring the stream into compliance. In this TMDL, the extent of impervious cover (% IC) in the watershed is used as a surrogate for the complex mixture of pollutant and non-pollutant stressors attributable to urban development, especially stormwater effects. By reducing the % IC using the options listed above in Part I, section 5, Implementation Recommendations, a number of urban stressors and their sources can be addressed simultaneously (e.g., toxic load from airport/road runoff and road sand; high flows related to high imperviousness; elevated water temperature from impervious surfaces and detention pond outflow; elevated nutrient levels from road and lawn runoff). The use of imperviousness as the TMDL target requires the application of the Impervious Cover Method.

Impervious Cover (IC) Method

The IC Method was developed by the Center for Watershed Protection (CWP) to assess the impacts of urbanization on small streams and receiving waters, and to document the linkage between the % impervious cover in watersheds and instream water quality. The IC Method was used by ENSR in a pilot project to develop TMDLs for streams potentially impaired by urban nonpoint source pollution (ENSR 2004). ENSR selected the IC Method for their pilot project "primarily because it provides a strong and straightforward link between water quality impairment and causal factors" (ENSR 2004). The IC Method can be used to estimate current annual runoff volume and loads for a range of pollutants using the current extent of watershed imperviousness (for current % IC determination see following section). The IC Method can also be used to estimate target volumes and loads based on a target extent of imperviousness. In this TMDL, target pollutant loads are presented primarily to describe potential loadings and determine load reductions. They do not represent end-of-pipe loadings, or loadings for individual storms. Rather, they represent total loads of pollutants entering a stream during small and large rainfall events occurring throughout the year and originating from non-distinct sources. Estimates shown here are therefore not appropriate for use in a permitting, enforcement, or monitoring context.

Impervious Cover and Landuse Information

As a first step for calculating the % impervious cover in the Birch Stream watershed, the watershed boundary (Part I, Fig. 1) was determined. This was done based on a drainage map obtained from the City of Bangor, on 10 m contour lines, and actual stormwater drainage systems. Watershed imperviousness was determined from landuse data and a conversion of landuse to % IC. Landuse data were derived from "Maine_Combo_Landcover", a GIS map layer developed by MDEP staff that combines data from Maine Gap Analysis Program (GAP) and USGS Multi Resolution Landcover Characterization (MRLC) coverages[1]. Both GAP and MRLC are based on 1992 Land-Sat TM satellite imagery. Metadata for Maine_Combo_ Landcover are maintained by the MDEP's GIS unit. Landuse information presented here includes the area above the confluence with Kenduskeag Stream, i.e., all areas draining into the impaired segment (Fig. 1). Within this area, landuse is dominated by high, low, and

[1] To minimize uncertainties in precise landuse type (e.g., different types of urban developments, forests or wetlands), the original 24 "Maine_Combo_Landcover" types present in the Birch Stream watershed were grouped into the nine generalized types shown in Fig. 1.

medium intensity development, which together account for 75 % of all landuses (Table 2, Fig. 1). Forests and grasslands account for 14 and 8 %, respectively, while other smaller landuses make up the remaining 3 %.

Table 2. Extent of various landuse types in the Birch Stream watershed. Letters b-f shown in the first column refer to the (urban) land cover types listed in Table 3. (Note: different terms are used here than in Table 3 for landuse types b-f to more accurately reflect actual landuse; also see footnote to Table 3.)

Landuse Type		Acres	%
b, c	High Intensity Developed	1,307	69.1
-	Forests (Upland Woody Vegetation)	264	13.9
-	Grasslands	146	7.7
e, f	Low Intensity Developed	65	3.4
d	Medium Intensity Developed	47	2.5
-	Other*	62	3.3
-	Total watershed area	1,891	100

* "Other" landuse types are [in order of decreasing area (≤32 acres) or percentage (≤1.7 %)] Tilled Agriculture, Wetlands, Water, and Very High Intensity Developed.

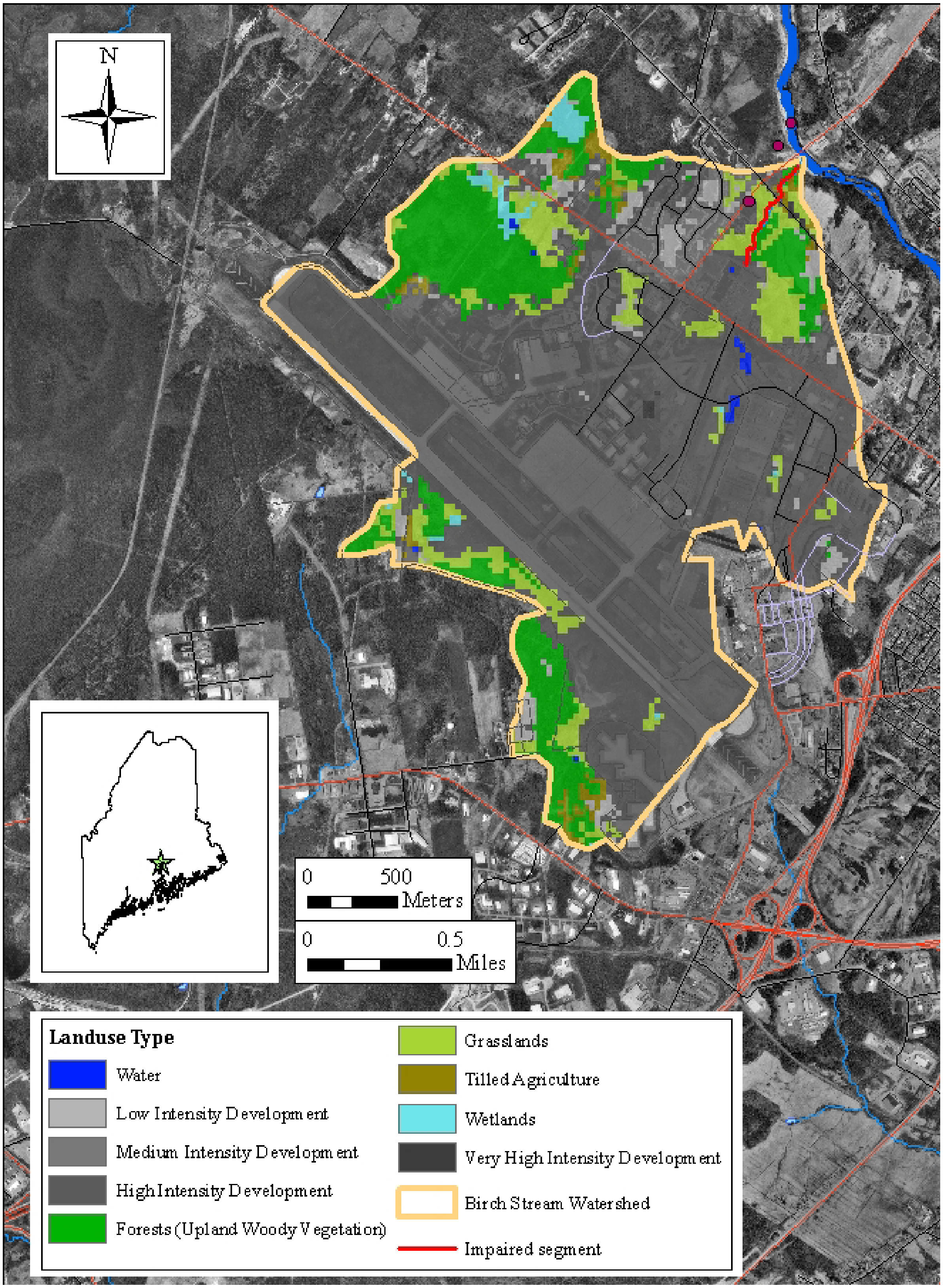
The method used to convert landuse to % IC was developed by MDEP staff (MDEP 2001b) by applying a % imperviousness formula to the "Maine_Combo_Landcover" GIS layer. The resulting values for imperviousness of certain land cover types in Maine are presented in Table 3. Calibration (i.e., groundtruthing) of the method led to the addition of a multiplier to give a final formula for watershed % IC of:

$$\text{Watershed \% IC} = 0.85 \; * \left(\frac{\sum_{a}^{f} (\text{Acres of landuse type} * \text{Estimated \% IC})}{\text{Total watershed area}} \right)$$

Where Acres of landuse type a-f[1] = see Table 2
Estimated % IC for land cover type a-f[7] in Maine = see Table 3
Total watershed area = see Table 2

[1] Landuse type 'a' does not occur in this watershed.

Fig. 1. Landuse in the Birch Stream watershed.



Using the formula shown on page 20, % IC for the Birch Stream watershed was estimated to be 33 %. It is not known how much of this total IC is impervious cover that is directly connected to the stream via hard surfaces or in close proximity, and from which runoff enters a waterbody untreated (i.e. is effective IC). Two retention ponds within the airport complex and one dry detention pond in a private facility in the lower part of the watershed provide some runoff treatment but the extent and effectiveness is unknown at this time. If an assessment carried out during the implementation phase of this TMDL finds that the treatment provided by these ponds is insufficient, the ponds will need to be modified or retrofitted with additional BMPs to provide adequate treatment for runoff.

Table 3. Estimated % impervious cover (IC) for urban land cover* types in the "Maine_ Combo_Landcover" GIS map layer (MDEP 2001b). Letters a-f shown in the first column refer to the landuse types listed in Table 2.

Land Cover Type		Estimated % IC
a	Urban Industrial	90.20
b	Dense Residential Developed	56.50
c	Commercial-Industrial-Transportation	54.04
d	High Intensity Residential	27.11
e	Low Intensity Residential	17.26
f	Sparse Residential Developed	11.98

* Because of the way land cover types were derived from two GIS datasets, terms used here do not necessarily reflect the actual landuse (e.g., residential). Land cover types do, however, accurately reflect the extent of imperviousness due to development associated with each category.

Estimation of Pollutant Loads

The Impervious Cover Method uses the percentage of IC in a watershed and other relevant parameters such as annual runoff, annual rainfall, pollutant concentration in runoff (event mean concentrations, EMC), and watershed area to estimate current and target annual stormwater runoff volumes and annual loads of pollutants (e.g., nutrients). The following three-step process is employed to estimate values (ENSR 2004):

1. Calculate Runoff Volume Coefficient

$$\mathbf{Rv = 0.05 + 0.9\ Ia}$$

Where Rv = Runoff Volume Coefficient
Ia = Impervious fraction

2. Calculate Annual Runoff Volume

$$\mathbf{R = P * Pj * Rv}$$

Where R = Annual runoff (inches)
P = Annual rainfall (inches)
Pj = Fraction of rainfall events producing runoff

3. Calculate Annual Pollutant Load

$$L = R * C * A * U$$

Where L = Annual pollutant load (lbs)
C = Pollutant concentration in stormwater (mg/L)
A = Watershed area (acres)
U = Unit conversion factor, 0.226

Parameter values can be obtained from the published literature or from local sources, and are most useful if they are region-specific. Table 4 shows the parameter values and their sources that were used for the annual load calculations for Birch Stream as shown in Table 5. Tables 4 and 6 list nutrients as pollutants because they were identified as significant stressors for Birch Stream (Part I, Table 2). Toxic contaminants were also identified as significant stressors but they are not listed in Tables 4 and 6 because no relevant event mean concentrations were available for the contaminants that exceeded criteria in Birch Stream (i.e., propylene glycol, aluminum, SVOCs). Pollutant concentrations from the general literature were used here for load calculations because only one data point was available from storm sampling in the Birch Stream watershed (MDEP/PETE 2005).

Table 4. Parameter values for IC model and their sources.

Parameter		Value	Source
Ia	Impervious fraction	33 %	GIS analysis
P	Annual rainfall (inches)	40.5 in	Bangor Airport (www.worldclimate.com)
Pj	Fraction of rainfall events producing runoff	0.9	CWP 2003
C	Pollutant concentration in stormwater (mean event mean concentration, EMC)	mg/L	CWP 2003 (Table 16)
	Total Phosphorus	0.32	
	Total Nitrogen	2.39	
A	Watershed area (acres)	1,891	GIS analysis

Using the parameters in Table 4 in the three-step process shown above, annual runoff volume and annual nutrient loads at the current % IC and at a target (lower) % IC can be estimated. An appropriate target % IC for Birch Stream was selected by considering local conditions (ameliorating and exacerbating) within the framework of the target % IC range of 6-10 % established by MDEP for Class B waterbodies (MDEP 2005). Given the specific conditions found at Birch Stream (Table 5), a target % IC of 8 % was set. Using this target % IC would reduce the projected stormflow runoff volume and pollutant load by 65 % (Table 6). As explained in “Impervious Cover Method”, above, estimates shown in Table 6 are not appropriate for usage in a permitting, enforcement, or monitoring context.

Table 5. Conditions considered in selection of target % impervious cover for Birch Stream.

Ameliorating conditions	Exacerbating conditions
Presence of a riparian buffer >10 m in width along 57 % of the stream (PETE/MDEP 2005)	Absence of riparian buffer along 43 % of the stream (PETE/MDEP 2005)
Macroinvertebrate community met Class C criteria in 4 out of 8 sampling events (PETE/MDEP 2005, MDEP unpublished data) indicating that local conditions can support minimum standards for aquatic life. (Note though that Birch Stream is a Class B stream.)	Impermeable soils (clays and silts of glacial-marine origin) reducing infiltration potential
	Long-standing pollution potential in upper part of watershed (military reservation)
	Urban development is predominantly of transportation and industrial kind, not residential

Table 6. Estimated annual stormwater runoff volume and annual loads for nutrients in Birch Stream at current and target % impervious cover (IC).

Pollutant	Runoff volume (inches per year)		Estimated annual load (lbs)		% Reduction
	At 33 % IC (current)	At 8 % IC (target)	At 33 % IC (current)	At 8 % IC (target)	
Stormwater	12.7	4.5			65
Total Phosphorus			1730	608	65
Total Nitrogen			12,919	4,542	65

Limitations of the Impervious Cover Method

The impervious cover (IC) method can be used to efficiently characterize water quality impairment and establish surrogate TMDL targets for % IC, or stormwater runoff volume, or pollutant reduction targets for watersheds that are impaired by stormwater (ENSR 2004). There are five limitations that affect the use of the method in Birch Stream as follows:

1. Limitation: The IC model applies to 1st through 3rd order streams.
   Effect: Birch Stream is a 1st order stream, i.e., use of the model is appropriate.

2. Limitation: This method does not account for non-stormwater point source pollutant loadings, so it would not be appropriate where these loadings are a significant source of impairment.
   Effect: There are no non-stormwater point sources of pollution in the watershed, and violation of aquatic life criteria in this watershed is believed to be caused by stormwater and/or nonpoint source pollution, and exacerbated by riparian and instream habitat disturbances.

3. Limitation: This method uses event mean concentrations for determination of pollutant loads. This will provide reasonable accuracy over long time periods (i.e., annual loads), but since concentrations vary significantly from storm to storm, this method should not be used for estimating loads for individual storm events.
   Effect: The method is used here only for estimating annual loads, not loads for individual storm events. In addition, it is emphasized that load estimates are primarily used for descriptive purposes (see section 3, subsection Impervious Cover Method).

4. Limitation: This method does not account for in-stream water quality processes.
   Effect: The magnitude and importance of in-stream water quality processes (e.g., contribution of the natural sources to the toxic load) is unknown and can therefore not be accounted for regardless of which method is used for load estimates.

5. Limitation: Additional site specific information is required for identification and specification of Best Management Practices (BMPs) to achieve TMDL goals.
   Effect: Suggestions for BMPs, remedial actions, and restoration techniques aimed at removing identified stressors, or mitigating their effects, are made in Part I, section 5. Implementation of these BMPs will aid substantially in reducing the % IC and its effects. However, a reduction of the IC by the full 25 % (from 33 % to 8 %) will require site specific information for optimal implementation of BMPs.

4. LOAD ALLOCATIONS

All Load Allocations (LAs) are given the same 7 % impervious cover allocation as the Waste Load Allocations (WLAs) (see next section). This approach was chosen because LAs must be accounted for but it was not feasible to separate the loading contributions from nonpoint sources, background, and stormwater. Adding a margin of safety of 1 % to the 7 % Load Allocation yields the Total Load Allocation of 8 % IC (see Table 7 and section 6.).

5. WASTE LOAD ALLOCATIONS

The entire Birch Stream watershed is classified as a “regulated area” under the NPDES Phase II Stormwater Program. Under this program, stormwater discharges are considered as point sources and are allocated as waste loads. Several NPDES permits have been issued to facilities in the watershed:

<u>Permit holder Maine Air National Guard</u>

- NPDES Phase I, multi-sector general permit (MSGP);
- NPDES Phase II, MS4 permit; and
- NPDES Phase II, Non-Traditional permit (federal facility with more than 50 employees within an urbanized area).

Permit holder Bangor International Airport (owned by the City of Bangor)

- NPDES Phase I, multi-sector general permit (MSGP); and
- NPDES Phase II, MS4 permit;

None of the permits issued to either facility has stipulations concerning flow.

In this TMDL, % IC is used as a surrogate for the complex mixture of stormwater runoff, pollutant and non-pollutant stressors attributable to urban development. The Total Load Allocation is set at 8 % IC. The 'WLAs' and 'LAs' are established at a % IC of 7 %, which allows for a margin of safety of 1 % IC as shown in Table 7. Resulting target pollutant (nutrients) loads are also shown in the table. Again, it should be stressed that the loads as shown in Table 7 are not appropriate for use in a permitting, enforcement, or monitoring context (see Part II, section 3, subsection Impervious Cover Method). They are broad estimates useful in approximating relative contributions and overall load reductions.

Table 7. Estimated target annual Total Load Allocation for runoff volume and nutrients in Birch Stream. WLA, Waste Load Allocation; LA, Load Allocation; MoS, Margin of Safety.

TMDL = WLAs/LAs (7 % IC) + MoS (1 % IC)	**Runoff volume (inches per year)**	**Pollutant (lbs per year)**		**% reduction**
		Total Phosphorus	**Total Nitrogen**	
Total Load Allocation (8 % IC)	4.5	608	4,542	65

6. MARGIN OF SAFETY

This TMDL includes an explicit margin of safety of 1 % impervious cover, which accounts for the uncertainty in the selection of a numeric water quality target of 8 % IC. An implicit margin of safety is built into the choice of % IC as the TMDL target because imperviousness has a multitude of effects on streams, all of which combine to affect aquatic life. Selection of only one parameter such as nutrients or toxic contaminants instead of % IC would result in a less comprehensive removal of likely stressors causing the impairment.

7. SEASONAL VARIATION

Critical conditions can occur for aquatic life and habitat in stormwater-impaired streams at both low and high flows. Frequent small storms can contribute large volumes of runoff and a mix of pollutants. High flows can cause channel alterations, increased pollutant loads from scouring and bank erosion, wash-out of biota, and high volume pollutant loading. Increased % impervious cover and the resulting increase in surface runoff reduces the amount of infiltrating rainfall that recharges groundwater. This diminished baseflow can further stress aquatic life and cause or contribute to aquatic life impairments through loss of aquatic habitat and increased susceptibility of pollutants at low flow. Because stormwater volume varies throughout the year, and stream impairment can be contributed at various flow volumes, use of the average stormwater volumes / event mean, annual mean, or other average runoff estimate to calculate an annual pollutant load is appropriate and adequately accounts for seasonal variation. Furthermore, specific BMPs implemented will be designed to address loadings during all seasons.

8. PUBLIC PARTICIPATION

Public participation in the Birch Stream TMDL development is ensured through several avenues. A preliminary review draft TMDL, which was reviewed by MDEP staff (M. Evers, D. Ladd, N. Marcotte, D. Miller, Bureau of Land and Water Quality; E. Logue, Director MDEP Eastern Maine Regional Office), was distributed to watershed stakeholder organizations including

- John Murphy, City of Bangor
- Maj. Eric Johns, Maine Air National Guard, Bangor
- Rodney Madden, Bangor International Airport, Bangor
- Sara McCabe, Penobscot County Soil and Water Conservation District
- Phil Ruck, CES, Inc., Brewer

Paper and electronic forms of the *Birch Stream TMDL, Draft Report* are made available for public review in three ways: the report is available for viewing at the Augusta office of the MDEP; it is posted on the MDEP Internet Web site; and a notice will be placed in the 'legal' advertising section of a local newspaper. The following ad will be printed in the Sunday editions of the Bangor Daily News on September 4 and 11. The U.S. Environmental Protection Agency (Region I) and interested public are provided a 30 day period (from August 31 to September 29) to respond with draft comments.

> *PUBLIC NOTICE FOR BIRCH STREAM - In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130, the Maine Department of Environmental Protection has prepared a Total Maximum Daily Load (TMDL) report (DEPLW0715) for Birch Stream in Bangor, Penobscot County. This TMDL report estimates the current extent of impervious surfaces, and the reductions in impervious surfaces and application of general stream restoration techniques required to enable the stream to meet Maine's Water Quality Criteria.*
>
> *A Public Review draft of the report may be viewed at the Maine DEP Offices in Augusta (Ray Building, Hospital St., Rt. 9) or on-line at: http://www.maine.gov/dep/blwq/comment.htm.*
>
> *Send all written comments by September 29, 2005 to Melissa Evers, Maine DEP, State House Station #17, Augusta, ME 04333, or email: Melissa.Evers@maine.gov*

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WEB-BASED RESOURCES FOR INFORMATION ON STORMWATER ISSUES AND BEST MANAGEMENT PRACTICES

Note that this list is only a starting point and does not attempt to be comprehensive.

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www.crjc.org/buffers/Introduction.pdf

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http://www.cumberlandswcd.org/Technical%20Assistance.htm

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http://www.maine.gov/dep/blwq/doceducation/nps/background.htm
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